USGS

WATER RESOURCES RESEARCH GRANT PROPOSAL

Title: River Scale Instream Flow Simulation (RIFS)

Focus Categories: SW, ECL, MET

Descriptors: Streams, Global positioning system, Aquatic habitat, Field methods

Duration: March 1, 2000 - Feb. 28, 2001

FY 1999 Federal Funds: $6,000

FY 1999 Non-Federal Funds: $12,103

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Critical Water Problem:

Physical habitat simulation is a part of the Instream Flow Incremental Methodology, which was developed in early seventies as a planning tool for the negotiations of in- and out stream water use. The method uses high precision measurements of physical conditions to predict flow related changes of habitat potential. Lately this technique was criticized for narrow focus on local scale issues, hence inadequacy for modern, more holistic management of running waters. This constrain is a result of methodological design requiring high spatial resolution for hydraulic calculation and therefore intensive sampling effort. In the process of generalization of the results to the scale relevant to the construction planning this high precision is rapidly being lost. On the other hand, this technique deals with functional relationship of physical attributes and biology making it highly attractive to large-scale approaches. Federal and New York State agencies and institutions managing in running waters strongly demand such an integrative decision support base. The intensive development of sampling and modeling techniques of recent years allows methodological adaptation of the instream flow models, to link both small and large scale techniques.

Expected Benefits

The technique developed here should provide practically tested template for future restoration approach, which better fits into modern river management concept. The project is intended to provide the methodology to effectively apply the principals of

physical habitat models into the scale of the whole river. It will shift the sampling effort from intensive micro-habitat survey, towards meso-habitat based mapping of the whole river sections. The change in the extent of various mesohabitat types in response to the flow variation will replace typical hydraulic models reducing the effort and the uncertainty introduced by common model constrains for low flow conditions. Use of meso-habitats (e.g. pool, run, riffle etc.) as a basic survey unit makes this approach more conform to typical biological sampling strategies and will allow better evaluation of the results. Furthermore, it allows the simplification of the survey process making the technique easier applicable and affordable for the local and state agency staff. The major advantage however is that, it will provide a solid base for quantitative assessment of habitat conditions of the whole river, embedded in the framework of more overall river basin assessment.

Nature, Scope, and Objectives

The proposed study is of methodological nature. It should be supported by ongoing study on the Quinebaug river in Massachusetts and Connecticut, which is a collaborative effort of private, state and federal institutions towards improvement of ecological status of the whole river.

The scope of the study proposed here is to design and test modeling technique, which will allow better assessment of habitat conditions at the larger scale and integration with river basin methods. It requires the design of adequate sampling and assessment strategy as well as technical considerations. In particular two objectives can be defined:

· Development and evaluation of overall sampling strategy.

· Test of sampling techniques combining GPS supported survey equipment with GIS background data and modern hydraulic sensors.

Methods, Procedures, and Facilities

It is proposed here that we will use the Quinebaug River (MA/CT) as a test case for developing our methodology. A 50 miles long study area on the Quinebaug River frequently changes due to geological, hydrological and human influences. The Quinebaug River is therefore considered as representing upcoming issues of large-scale river restoration projects in highly urbanized areas of United States.

Under the influence of this case the preliminary concept of survey strategy was developed and is described as follows.

The survey will use the river specific meso-habitat features (pool, riffles etc.) as a basic unit. It will be supported by application of real time GPS positioning system, which, together with existing GIS maps and aerial photographs, will allow the effective orientation in the terrain. Using received locations relatively accurate map of instream

features, together with shore line development and human impact sources will be constructed. The occurring features will be quantified for whole study area at low, mean and high flow conditions respectively. The change in meso-habitat distribution will be used for description of flow related habitat changes.

Based on the results of each of above surveys, the number of typical meso-habitats will be randomly selected and the physical conditions in each meso-habitat type will be described using 2-Dimentional stratified sampling method. The average physical conditions (hydraulics and morphology) along with their variability will be assigned to each meso-habitat using multiple measurements in in situ selected homogenous units. This characteristic will be used to assign the meso-habitat type specific fish communities found in the following biological survey. Consequently fish community based suitability of each meso-habitat-type for different flow conditions can be established. Based on the results of the first survey Flow related change of the suitability will be quantified for the whole study area.

In order to develop the above concepts to fully operational approach, practical tests of the process and the instrumentation, followed by necessary adaptations, must be conducted. In the first step the whole technological process should be simulated using available and dummy data. Secondly necessary instrumentation needs to be provided and tested in real world conditions. The field survey computer GAC PRO (www.geoastor.ch) was chosen as a tool for mapping of meso-habitat distribution in the field. Together with real time GPS units this equipment allows to draw the extends of meso-habitat features on site, even in the most harsh environmental conditions. The adaptation of software to river specific issues and the test in the river sites is still necessary.

The methodology will be evaluated during the currently funded Quinebaug River project. The resulting conclusions will be used for adaptation of the original design as well for definition of strength and limitations of the method.

The facilities available for the project include PC computers, survey equipment, experienced staff and the support of involved institutions. The operational expenses for the fieldwork are provided by the Quinebaug river project. The GIS and aerial photography data necessary for survey process are already available to the team.

Related Work

The effort towards development of community level, large scale habitat modells is not very intensive. There are only two significant approaches used and developed world wide. The first one is linking statistical descriptions of local habitat conditions with multivariate preference models for common European species and summarizes at them the community level. It applies also specifically developed statistical hydraulic model. It was developed at the University of Lyon in France by Nicolas Lamouroux and presented lately on the 3rd Ecohydraulic Symposium in July 1999 in Salt Lake City in presentation Instream Habitat Modeling for Fish Communities. The principles of second method were developed in US by Mark Bain (1996)[1]. Based on the intensive samples on the rivers,

five fish community habitat-assemblages were derived using multivariate statistics. The quantity of these assemblages defines the habitat quality. This principle should be applied here embedding it in the overall meso-habitat framework. The meso-habitat mapping technique belongs to established approaches used in the IFIM framework, not however in proposed intensity and accuracy which become feasible due to used technological means. The GPS technology is used with success for large river domains as presented by J. Schoemaker, J. Ludlow, T. Hardy “A system for collection of high precision bathymetry” also on the 3rd Ecohydraulic Symposium in July 1999 in Salt Lake City. It was not however successfully applied on the small rivers. The Depth Velocity Position Bar is a multiplex instrument developed in Austria for measurement of physical habitat attributes in streams (Parasiewicz, 1998). The PHABmeter is an improved next generation of this instrument using more sophisticated technology.